ARCHITECTS AND
THE ENVIRONMENT

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PROGRESSIVE
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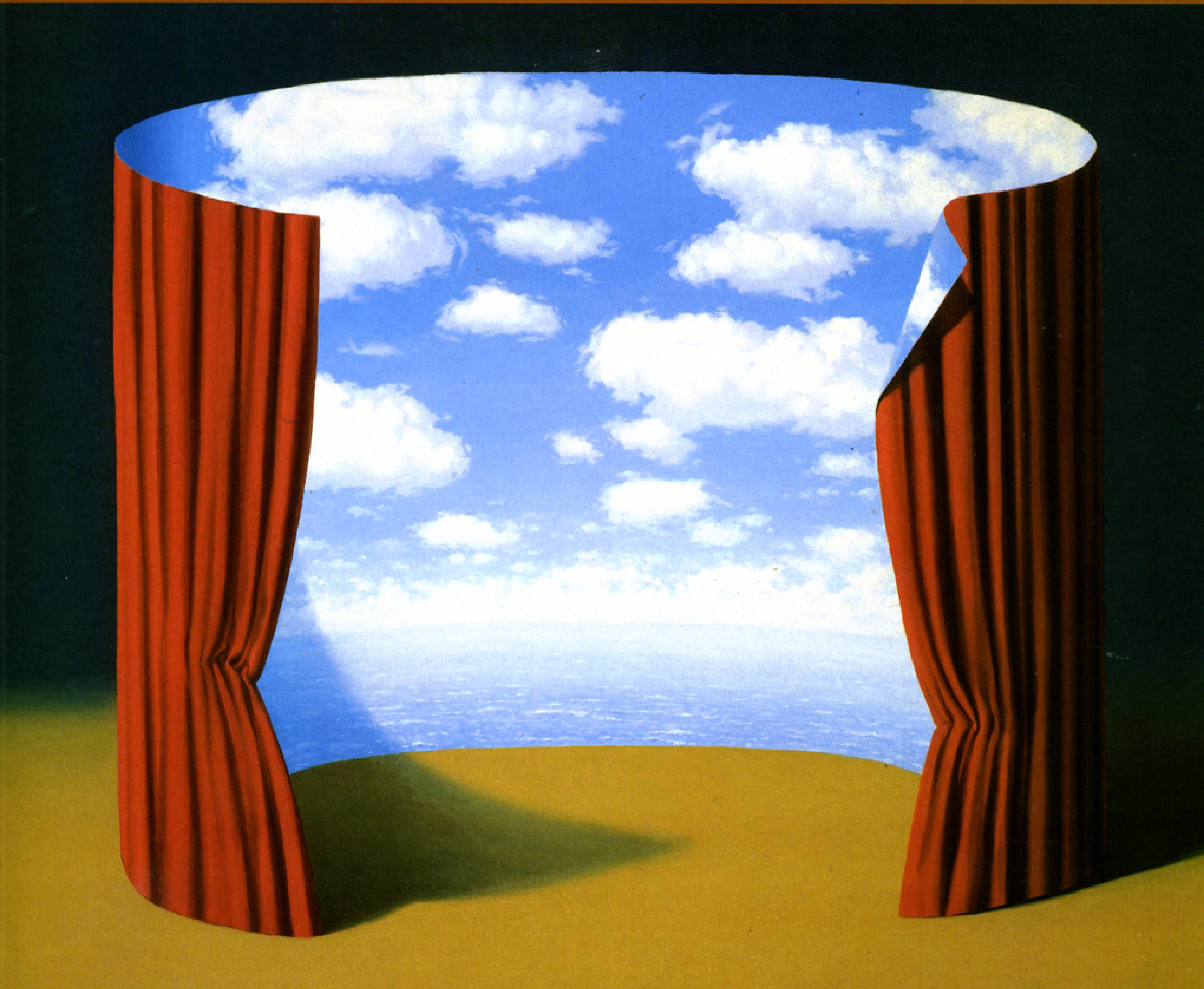


Technics: Mercury, et al.

Peter Retondo of Sim Van der Ryn Associates offers one architect's view of recent developments involving domestic indoor pollution and what designers can do while we wait for more evidence.

If you thought that the health hazards from mercury additives in indoor paints had been resolved by their highly publicized removal last August, take a closer look. Nothing is as simple as it seems in the Gordian tangle of pollution research, overlapping agencies, risk assessment, and fear of litigation. The history of mercury regulation reveals succinctly how our system works - or fails to work - to detect health hazards inherent in building practices, and how attentive we architects must be to drive home real results.

Students from an earlier, more permissive era can remember rolling beads of mercury around with pencils on their high-school chemistry lab tables. Mercury has had a long history of usefulness and scientific inquiry. Its toxicity has been well established, as is implicit in its architectural role as a constituent in four organic fungicides[1] used since the early 1960' in latex paints. Because mercury is liquid at .room temperature it can become a gas, and thus presents an indoor air hazard. As early as the 1940', mercury had come to the attention of the medical community as a cause of a previously unexplained, rare, but serious, childhood disease.[2] It was an instance of that disease (Acrodynia) in a four-year-old boy last year, linked to a new paint job in the family home using latex paint with mercury additives,[3] that finally brought about a consensus against the use of mercury in paints.

There is a disturbing parallel between the cases of mercury and asbestos. The facts concerning disease in asbestos workers had first been exposed in the 1930s -40 years before we finally took regulatory action and industry was shocked by the liabilities imposed on the Johns-Manville Corporation. Similarly, it took 30 years to bring mercury under regulatory control. The poisoning of Japanese towns by the consumption of shellfish contaminated with methyl mercury had made world news in 1956 and again in 1965. A 1963 article in the *New England Journal of Medicine*[4] exposed mercury paint additives as a cause of Acrodynia, and investigators discovered the mechanism whereby the mercury compounds in paints were transformed into free mercury vapor in indoor air. But an attempt by the Environmental Protection Agency (EPA) in 1972 to ban mercury's use in paints failed, as industry technicians piled up 4000 pages of testimony, supported by studies such as that published in 1965 in the *Journal of Applied Chemistry*,[5] which concluded that the amount of mercury released into the air by paints was likely to be far below the recommended minimum dose for industrial workers.

Although higher than in outdoor air, indoor concentrations of pollutants associated with building products are generally much lower than those associated with the industrial workplace. It must be realized, however, that effects on susceptible people (the elderly, children, fetuses), accumulation over longer periods of time, and the political reality that industrial standards are compromised by pragmatics, have been neglected. In retrospect, these low indoor levels have fostered complacency. So it was not until 1990, in an atmosphere of growing concern over indoor pollution in general, that a voluntary removal of mercury mildewcides from the market was negotiated by the EPA.

That removal, though, is not complete, and this is where architects can make a difference in helping ensure the health of the occupants of their buildings. As part of the deal, paint manufacturers have been allowed to sell their existing inventory of mercury-containing paint. In addition, they are still allowed to manufacture *exterior* paints containing mercury compounds, and because it is reported that painters may prefer using mercurytreated paints,[6] the possibility exists that - without pointed specifications to the contrary - such paints may be used indoors. It is, therefore, recommended that architects specify mercury-free interior paints, and the EPA has a mercury hotline (800-858-7378) to help specifiers determine whether a particular brand is mercury-free. This is especially important now, while distributors are anxious to reduce their inventories of mercurycontaining paints. The hotline is also a source for information about termite chemical soil treatments and other pesticides.

Mercury is the latest in a series of construction materials to be regulated by the government, and will certainly not be the last. As a senior researcher for the EPA has pointed out, "It will be prudent for architects... to be alert to substances that rather suddenly attract the attention of the public and public health officials."[7] Architects can do more, however, than just pay attention to government regulations concerning hazardous building materials (see sidebar).

Seeking Higher Standards

Some have argued that formaldehyde emissions are no longer an issue after the banning of

References

1 PMA (phenylmercuric acetate) CMPA (3-chloromethoxy-propylmercuric acetate); PMDS (Di-phenylinercury-dodecenyl-succinate); and PMO (phenyhmercuric oleate).

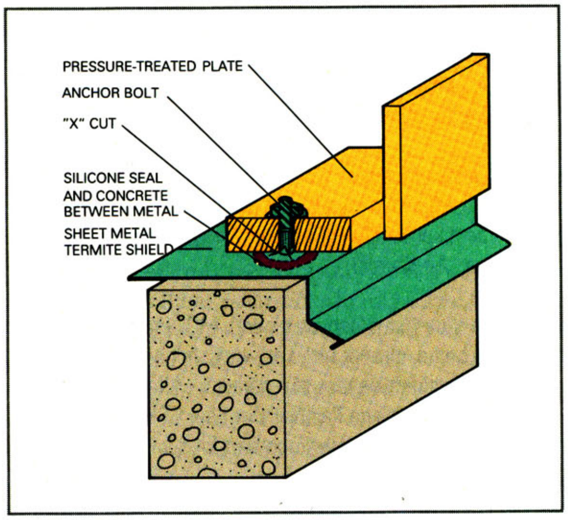
2 "Mercury - an Element of Mystery" (editorial), Thomas W. Clarkson, *New England Jour-7ral o/ Medicine*, Oct. 18, 1990, pp. 1137-39.

3 "Mercury Exposure from Interior Latex Paint," Mary M. Agocs et al, *New England Journal of Medicine*, Oct. 18, 1990, pp. 1096-1101.

4 "Mercury in House faint as a Cause of Acrodynia: Effect of Therapy with N-acetyl-D. 1-penicillamine," S.Z. Hirschman et al, *Near England Journal* of *Medicine*, 1963, 269: 889-93.

5 "The Loss of Mercury from Fungicidal Paints," C.G. 'Taylor, *Journal* of *Applied Chemistry*, May, 1965, pp. 232-36.

6 Personal communication, Bruce Tichenor, Chief, Hazardous Air Technology Branch, Air and Energy Engineering Research Laboratory, EPA.



TERMITE SHIELD

urea formaldehyde foam insulation (UFFI), the major source of formaldehyde poisoning in mobile homes that made the problem a *cause célèbre.* The fact remains, though, that there are no U.S. regulations concerning acceptable formaldehyde levels in domestic indoor air. The EPA's industrial threshold value is 1.0 parts per million (ppm), whereas Germany, for example, requires a standard of 0.1 ppm,[8] and some researchers argue for domestic levels as low as 0.03 ppm[9] (at the upper end of the average range for outdoor air[10]). In this atmosphere of confusion, some members of the wood-products industry – major users of urea- and phenol-formaldehyde resin binders – have argued that the trend towards phenol formaldehyde (the binder used in typical exterior plywood products), is enough of a step in the right direction, since its formaldehyde emissions are much lower than ureaformaldehyde's. Louisiana Pacific, however, is pioneering the use of an isocyanate binder, which, as far as is known, poses no toxic emission hazard.[6] Their Inner Seal® oriented strand board products and exterior sidings use isocyanate as a binder in a process that no other U.S. manufacturer has yet duplicated. Although they still use a phenol-formaldehyde coating at the surface of some of these products, the formaldehyde emission rate is significantly reduced. Architects are in a position to encourage such efforts in innovation through the power of specifications.

Higher standards can similarly be applied to other materials. According to recent studies, the constituent in latex carpet backings, 4-phenylcyclohexane (4-PC), is not known to be toxic,[6] yet it has an extremely annoying odor, and is detectable in concentrations much lower than most volatile organic compounds (VOCs).[11] If we follow a standard based on human senses and occupant comfort, we would seek to eliminate this unpleasant agent (see table for recommendations)

Environmental Illness

People with multiple chemical sensitivities (MCS) have been reduced to lives of misery – in some cases confined to their homes with special sanctuary rooms equipped with air purifiers and free of all materials producing VOC emissions or odors. Their syndrome is typically acquired and associated with a specific toxic exposure incident. The American Academy of Environmental Medicine comprises 500 physician members with practices specializing in the disease. Architectural strategies have centered on assiduous exclusion of materials containing VOCs, especially finish materials such as carpet, particle board, plywood subfloors, adhesives, and paints. Dr. Jeffrey Anderson, a specialist in environmental illness, has witnessed the regression of symptoms in over 70 cases of MCS after material-minded remodeling of patients' homes.

Subjective testing (by sniffing) by MCS sufferers is often the only way of assessing the acceptability of some materials. Four paint companies, three of them West German, have gained acceptance by the MCS community: Livos®, Biofa®, Auro®, and AFM®. The first three are part of an environmental consumer movement in Germany that has been gaining strength for 25 years. "Organic" or "citrus base" paints, the chemistry of which is based on dissolved natural resins, have captured 15 percent of the market there. The fourth is a U.S. manufacturer who has specialized in providing for the environmentally ill, and who has used a chemistry based on water emulsions of inorganic polymers. Our firm has been unable to locate scientific studies that compare these paints with conventional U.S. products; our recommendation is based on anecdotal evidence from the MCS community. These paints raise the cost of coatings, but because most of the cost of painting is in labor, the increase is not particularly significant. U.S. painting contractors have reported satisfactory experience with application and durability of the products.

7 "Research Overview: Sources of Indoor Air Pollutants," W.G. Tucker, EPA report 600/D-87/207, 1987.

8 Solplan Review, *August-September 1987.*

9 *Air Quality,* Thad Godish, Lewis Publishers, Chelsea, Michigan (800) 272-7737, 1985.

10 *Exposure to Formaldehyde from Indoor Air,* Elizabeth Ota and Elliot Mulberg, California Air Resources Board, 1990, p. 9.

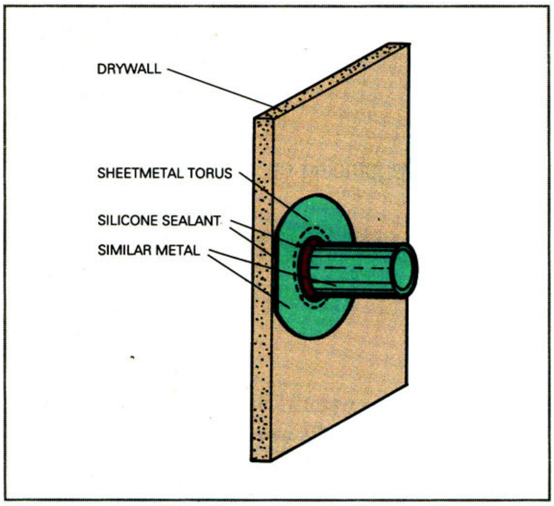
11 *Emissions of Air Pollutants from Indoor Materials: An Emerging Design Consideration,* G.W. Tucker, EPA Report 600/D-88/191, 1988.

12 "Building Materials and Indoor Air Quality," Hal Levin, *Journal of Occupational Medicine,* Vol. 4, No. 4, Winter 1989, pp. 667–693.

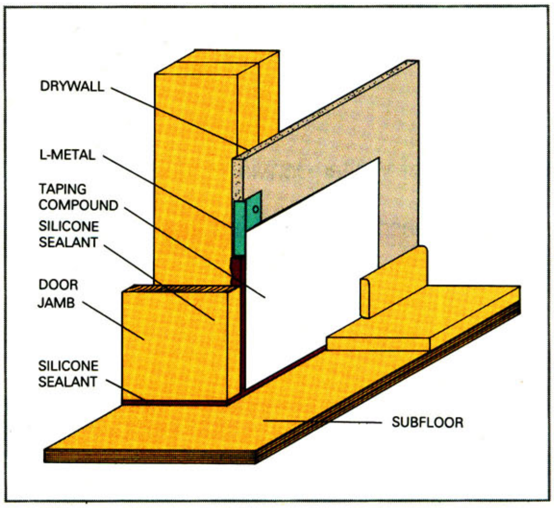
MATERIAL/FEATURE	PROBLEM	RECOMMENDATION
Topical biocidal solutions (Cuprinol, pentachorophenol, etc.)	Contact poisons	Use is typically superfluous; use redwood, cedar, cypress, or alternative masonry materials (pressure treated wood okay unexposed). Avoid outdoor use of susceptible woods like oak, provide adequate separation from ground, and detail maximum ventilation to evaporate rainwater.
Copper water supply tubing	Lead solder now banned by UPC, but still available; flux runs into pipes during soldering.	Specify lead-free solder; require steam or superheated water back-flush of system before installation of fixtures
Plastic water supply tubing	Tubing and glues leach solvents and chlorinated hydrocarbons into water.	Do not use plastic for supply water.
UFFI (urea formaldehyde foam insulation)	Severe emissions of formaldehyde, a moderately poisonous gas. Unobtainable for most applications.	Do not use UFFI. Alternatives for retrofit: blown-in cellulose or Air Krete®, a non-toxic cementitous foam with R-value of about 4 per inch, pump-applied on-site for about $1 per square foot for R-13.
Fiberglass insulation	Glass wool dust is a possible carcinogen[1]; Phenol-formaldehyde resin binder (minor problem).	Epidemiological studies of industry workers give ambiguous results. Caution advised! Seal finished installation from contact with indoor air. There should be no possibility of contact with building occupants. Excellent alternative: Air-Krete®.
Plywood, particle-board	Formaldehyde emissions from urea-formaldehyde and phenol-formaldehyde resins.	Avoid products with urea-formaldehyde binder: MDF (medium density fiberboard), particle board, interior rated plywood, hardwood plywoods (typically). Phenol-formaldehyde less of a problem. Alternative for structural applications: Louisiana Pacific Inner Seal OSB with isocyanate resin (see text), especially important for subfloors.
Forced-air heating systems	Poorly maintained filters breed molds; cold air returns and AC cooling coils are condensation sites, breeding aeropathogens; duct work harbors dust; system distributes contaminants[2].	Think in terms of building conditioning rather than air conditioning for thermal comfort. Radiant systems, especially in-slab, are preferable and save energy as well. Passive solar heating and cooling measures are healthier and more pleasant.
Garage	Exhaust fumes from car warm-up, find ways into the house[2].	Detach garage; breezeway connection okay.
Indoor paint	VOC emissions; see text for mercury emissions	Specify mercury-free paints; bake out and ventilate completed building to avoid initial high VOC levels; alternative paints with low toxicity, especially for persons with MCS (multiple chemical sensitivities) include Livos, Auro, Biofa, and AMF. Good scientific comparisons on paints are not available, but anecdotal information indicates the four mentioned above have comparatively low toxicity.
Plastic foam insulation	VOC (volatile organic compounds) emissions; highly toxic smoke in fire.	Avoid. Alternative: Foamglas (Pittsburgh Corning) is an acceptable but expensive substitute where compressive strength is required; Air-Krete is a good substitute otherwise.
Gas stoves and unvented gas heaters	Air pollution from combustion products: CO_2, CO, nitrogen oxides, formaldehyde	Do not use unvented gas heaters. Electric stoves are preferable to gas from an air-quality point of view. For gas stove installation, specify electronic ignition and always provide exhaust hood with maximum size blower, exhausted outside the house.
Carpet	Harbors dust, molds, and adsorbed VOCs. Latex backings emit VOCs, including 4-PC (4-phenylcyclohexane). Glues outgas.	Best to avoid carpets altogether, especially in areas where they might become damp. If they must be used, do not glue down, use jute pads, specify carpet without latex backing (woven backing).
Vinyl flooring	Material and adhesives outgas.	A linseed oil/cork linoleum from Holland (Forbo) is available as a substitute, especially for those with MCS. Price is comparable to typical commercial vinyls,and reputation for durability is good. AFM and Auro make low VOC adhesives. Ceramic tile is a totally non-toxic

[1] *Indoor Pollutants,* Committee on Indoor Pollutants, National Research Council: 1981, p. 130.

[2] "Role of Ventilation in the Causation of Building-Associated Illnesses," Philip R. Morey and Douglas E. Shattuck: *Occupational Medicine State of the Art Reviews,* vol 4, no. 4, Winter 1989, pp. 625-42.



INSECT BARRIER DETAILS



INSECT BARRIER AT PENETRATIONS

Post-construction Contamination

Insect problems are habitually dealt with after the problems have occured, through the application of toxic insecticides. Because pesticide use is a consumer issue and is not a part of the design or construction process, we tend not to think of it as an architectural issue. On the contrary, however, the architect can play an important role in the prevention of unnecessary pesticide use through preventive measures. The principles of prevention are simple: Good fences make good neighbors – detail the building to provide physical barriers. Where gardening is expected adjacent to a foundation, increase the code clearance (from ground to wood) from 6″ to 12″. Termite shields add protection at little extra cost. Stucco should not extend to the ground, as is common practice, but should also be kept away from contact with earth. A fence post sunk in the ground next to the building and in contact with the siding is an example of a common peripheral invitation to termites (the same is true for trellises, and other appurtenances).

The logic of detailing to avoid invasion by ants, silverfish, roaches, etc., flows from the question, "When was the last time you saw an insect crawl through a taped drywall corner?" Applying the same level of attention to create a preventive envelope at drywall and subfloor joints, and door and window jambs, will prevent most insect intrusion. This means that areas left unfinished by most builders should be taped out, including those behind cabinets and bathtubs. It also means sealing the wall at pipe stub-outs and sealing electrical boxes. Where caulking is used for this purpose, we recommend silicone caulk because it holds up better and outgasses less than most others.[12]

This kind of detailing points out another barrier to improving indoor environmental quality: The building industry resists changing standard construction practices, which favor visible results and the lowest cost. Many contractors and their subs ignore fine-level details called out in the plans until the job is under construction, and then raise objections to any unanticipated extra work; it would be a good idea to draw attention to this material in your bid invitations, and to include a separate section in specifications. With patience and persistence, architects can take a leading role in bringing about improved practices.

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Acknowledgment

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Recommended Reading

Indoor Air Pollution Control, Thad Godish, Lewis Publishers, Inc., Chelsea, MI (800) 272-7737, 1989, 400 pp., $65.

Indoor Air Quality Update, a monthly newsletter edited by Hal Levin, Cutter Information Corp., Arlington, MA (617) 648-8700, $267 per year.

Problem Buildings: Building-Associated Illness and the Sick Building Syndrome, Occupational Medicine State of the Art Reviews, vol. 4, no. 4, James Cone and Michael Hodgson, editors, Hanley and Belfast, Inc., Philadelphia (215) 546-7293, 1989, 240 pp., $34.00.

Residential Indoor Air Quality and Energy Efficiency, Peter Dupont and John Morrill, American Council for an Energy Efficient Economy, Washington, D.C. (202) 429-8873, 267 pp., $24.50.

Ventilation for Acceptable Indoor Air Quality, Standard 62–1989, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta (404) 636-8400, 1989, 26 pp., $42.

What Architects Can Do

Recognizing that regulatory minimum dose standards are keyed to serious health consequences, architects can strive to maintain a higher standard, based on occupant comfort and sense of well-being. This goal will have the beneficial side effect of putting the profession ahead of regulatory machinery and litigation liability.

Architects should be aware that a special group, those with "environmental illness" or MCS (multiple chemical sensitivities), requires special consideration, both in their homes and in public buildings. The percentage of the U.S. population with chemical sensitivity has been estimated as high as 15% for mild effects, and 1–5% for serious cases.

Architects can design details to reduce post-construction contamination due to extraneous agents. In other words, look beyond the immediate task of building and assume greater responsibility for the ecology of the building.